

C4108 Log Data Report

Borehole Information:

Borehole: C4108		Site: 216-A-10 Crib			
Coordinates (WA State Plane)		GWL (ft)¹: Not reached		GWL Date: 4/15/2003	
North N/A ³	East N/A	Drill Date April 2003	TOC² Elevation N/A	Total Depth (ft) 90	Type Percussion

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	0	6 7/16	5 7/16	0.5	0	88
The logging engineer measured the casing stored by the driller using a steel tape. Measurements were rounded to the nearest 1/16 in. Casing thickness was calculated.						

Borehole Notes:

Zero reference is the ground surface. This borehole was logged through the drillpipe. The driller reported that each section of casing is about 10 ft long with flush outside joints.

Logging Equipment Information:

Logging System: Gamma 2E	Type: 70% HPGe
Calibration Date: 03/2003	Calibration Reference: GJO-2003-430-TAC
Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Logging System: Gamma 1C	Type: High Rate Detector
Calibration Date: 02/07/02	Calibration Reference: GJO-2002-309-TAR
Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Logging System: Gamma 2F	Type: Moisture (H380932510)
Calibration Date: 10/2002	Calibration Reference: GJO-2002-387-TAC
Logging Procedure: MAC-HGLP 1.6.5, Rev. 0	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4/Repeat	
Date	4/14/03	4/16/03	4/16/03	4/16/03	
Logging Engineer	Pearson	Pearson	Pearson	Pearson	
Start Depth (ft)	90.5	45.0	36.0	48.0	
Finish Depth (ft)	44.0	35.0	1.0	38.0	
Count Time (sec)	100	100	100	100	
Live/Real	R	R	R	R	

Log Run	1	2	3	4/Repeat	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	0.5	0.5	1.0	0.5	
ft/min	n/a ⁴	n/a	n/a	n/a	
Pre-Verification	BE021CAB	BE023CAB	BE023CAB	BE023CAB	
Start File	BE021000	BE023000	BE023021	BE023057	
Finish File	BE021093	BE023020	BE023056	BE023077	
Post-Verification	BE021CAA	BE023CAA	BE023CAA	BE023CAA	
Depth Return Error (in.)	0	n/a	0	0	
Comments	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.	None	

High Rate Logging System (HRLS) Log Run Information:

Log Run	1	2/Repeat			
Date	4/16/03	4/16/03			
Logging Engineer	Pearson	Pearson			
Start Depth (ft)	62.0	62.0			
Finish Depth (ft)	57.5	59.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	0.5	0.5			
ft/min	n/a	n/a			
Pre-Verification	AC065CAB	AC065CAB			
Start File	AC066000	AC066010			
Finish File	AC066009	AC066016			
Post-Verification	AC066CAA	AC066CAA			
Depth Return Error (in.)	n/a	0			
Comments	No fine-gain adjustment.	None			

Neutron-Moisture Logging System (NMLS) Log Run Information:

Log Run	1	2/Repeat		
Date	4/17/03	4/17/03		
Logging Engineer	Pearson	Pearson		
Start Depth (ft)	90.5	65.0		
Finish Depth (ft)	0.25	55.0		
Count Time (sec)	n/a	n/a		
Live/Real	n/a	n/a		
Shield (Y/N)	N	N		
MSA Interval (ft)	n/a	n/a		
ft/min	1.0	1.0		
Pre-Verification	BF046CAB	BF046CAB		
Start File	BF046000	BF046362		
Finish File	BF046361	BF046402		
Post-Verification	BF046CAA	BF046CAA		
Depth Return Error (in.)	0	0		

Log Run	1	2/Repeat		
Comments	None	Repeat section.		

Logging Operation Notes:

During all log runs, zero reference was the ground surface, and the borehole was logged through drill pipe.

SGLS data were collected using Gamma 2E. Pre- and post-survey verification measurements employed the Amersham KUT (^{40}K , ^{238}U , and ^{232}Th) verifier with serial number 082. Logging was performed without a centralizer installed on the sonde. At the end of log run 1, the sonde was warm to the touch upon retrieval from the borehole.

HRLS data were collected using Gamma 1C. Pre- and post-survey verification measurements employed the ^{137}Cs verifier with serial number 1013. Logging was performed with a centralizer installed on the sonde.

NMLS logging was performed with a centralizer installed on the sonde.

Analysis Notes:

Analyst:	Sobczyk	Date:	4/21/03	Reference:	GJO-HGLP 1.6.3, Rev. 0
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SGLS pre-run and post-run verification spectra were collected at the beginning and end of each day and compared to the control limits established on April 10, 2003. The verification spectra were all within the control limits. The peak counts per second (cps) at the 609-keV, 1461-keV, and 2615-keV photopeaks on the post-run verification spectra as compared to the pre-run verification spectra for each day were between 2 percent lower and 8 percent higher at the end of each day.

HRLS pre-run and post-run verification spectra were collected at the beginning and end of each day. The spectra were within the acceptance criteria for the field verification of the Gamma 1C logging system (HRLS).

NMLS pre-run and post-run verification spectra were collected at the beginning and end of the day and compared to the control limits established on 12/05/2002. The pre-run verification spectrum registered 740 cps, which is slightly above the upper control limit of 735 cps.

Log spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Post-run verification spectra were used to determine the energy and resolution calibration for processing the data using APTEC SUPERVISOR. Concentrations were calculated in EXCEL (source files: G2EMar03.xls and G1CApr03). Zero reference was the ground surface. On the basis of the measurements supplied by the driller, the casing configuration was assumed to be one string of 6-in. casing to 90.5 ft. The casing correction factor was calculated using a 6-in. casing thickness of 0.5 in. This casing thickness is based upon the field measurement. Water corrections were not needed or applied to the data.

Using the SGLS, dead time greater than 40 percent was encountered in the interval from 58 to 61.5 ft and at 49.5 ft, and data from these regions were considered unreliable. At SGLS dead time greater than 40 percent, peak spreading and pulse pile-up effects may result in underestimation of activities. This effect is not entirely corrected by the dead time correction, and the extent of error increases with increasing dead time. SGLS dead time corrections were applied when dead time surpassed 10.5 percent. The HRLS was utilized to obtain data where the SGLS dead time exceeded 40 percent.

NMLS log spectra were processed in batch mode using APTEC SUPERVISOR to determine count rates. The volume fraction of water was calculated in EXCEL, using parameters determined from analysis of recent calibration data. Zero reference was the ground surface. The neutron moisture calibration is based on

a typical 6-in. casing with a thickness of 0.28 in. No casing correction function is available for the neutron log. The effect of the thicker casing may be to underestimate the moisture content.

Log Plot Notes:

Separate log plots are provided for gross gamma and dead time, gross gamma and volume fraction of water, naturally occurring radionuclides (^{40}K , ^{238}U , and ^{232}Th), and man-made radionuclides. Plots of the repeat logs versus the original logs are included. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing correction. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations on the combination plot rather than the ^{214}Bi peak at 609 keV because it exhibited slightly higher net counts per second.

Results and Interpretations:

^{137}Cs and ^{154}Eu were the man-made radionuclides detected in this borehole. ^{137}Cs was detected in the interval from 39.5 ft through total depth (90.5 ft) at concentrations ranging from 0.3 pCi/g to 3,100 pCi/g. The maximum concentration of ^{137}Cs was measured at 61 ft. ^{154}Eu was detected in the intervals from 41 through 46 ft, 62.5 through 69.5 ft, and 83.5 ft through 87 ft at concentrations ranging from 0.4 pCi/g to 2.0 pCi/g. The maximum concentration of ^{154}Eu was measured at 69 ft.

Recognizable changes in the KUT logs occurred in this borehole. The low KUT concentrations between 30 and 33 ft probably correspond with the rock fill that is located near the base of the crib. The volume fraction of water is below 2 percent in the interval from 33 through 40 ft.

The plots of the repeat logs demonstrate reasonable repeatability of the HRLS, SGLS, and NMLS data. ^{137}Cs (662 keV) concentrations are comparable between the repeat and original HRLS log runs. The man-made radionuclides and the natural radionuclides at energy levels of 662, 1274, 609, 1461, 1764, and 2614 keV are comparable between the repeat and original SGLS log runs. The neutron-moisture and its repeat are within the acceptance criteria.

¹ GWL – groundwater level

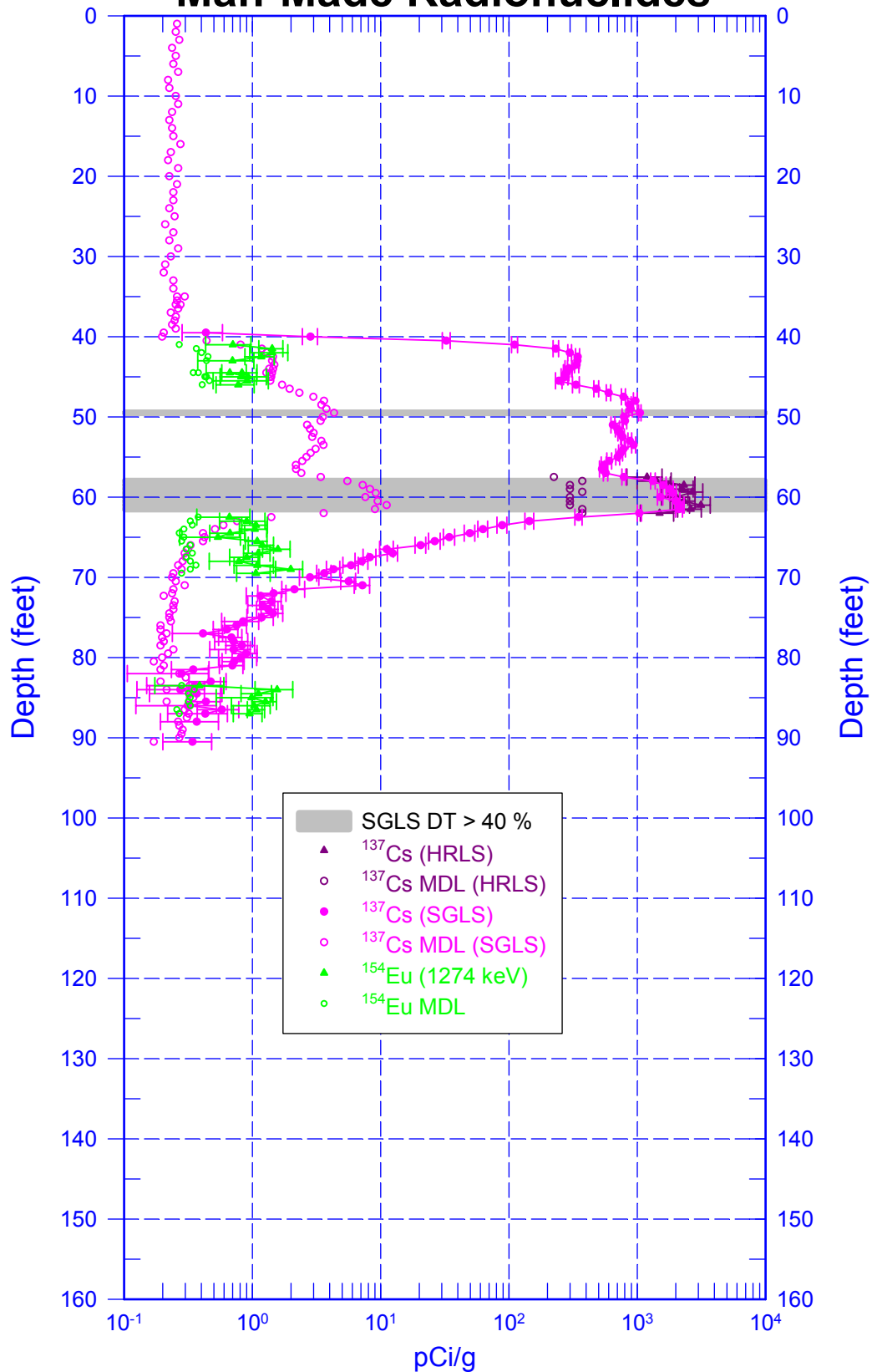
² TOC – top of casing

³ N/A – not available

⁴ n/a – not applicable

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Man-Made Radionuclides

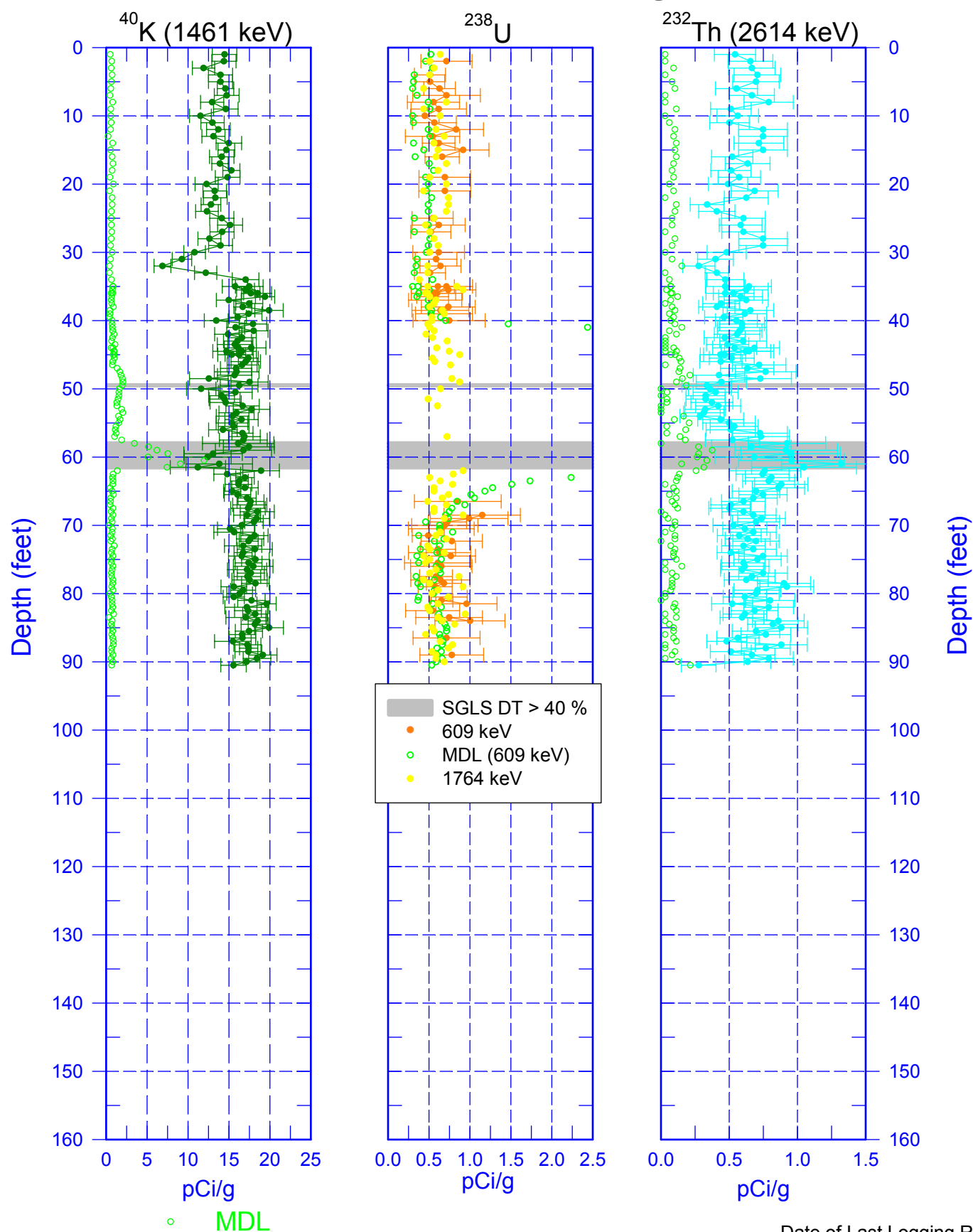


Zero Reference = Ground Surface

Date of Last Logging Run
4/16/2003

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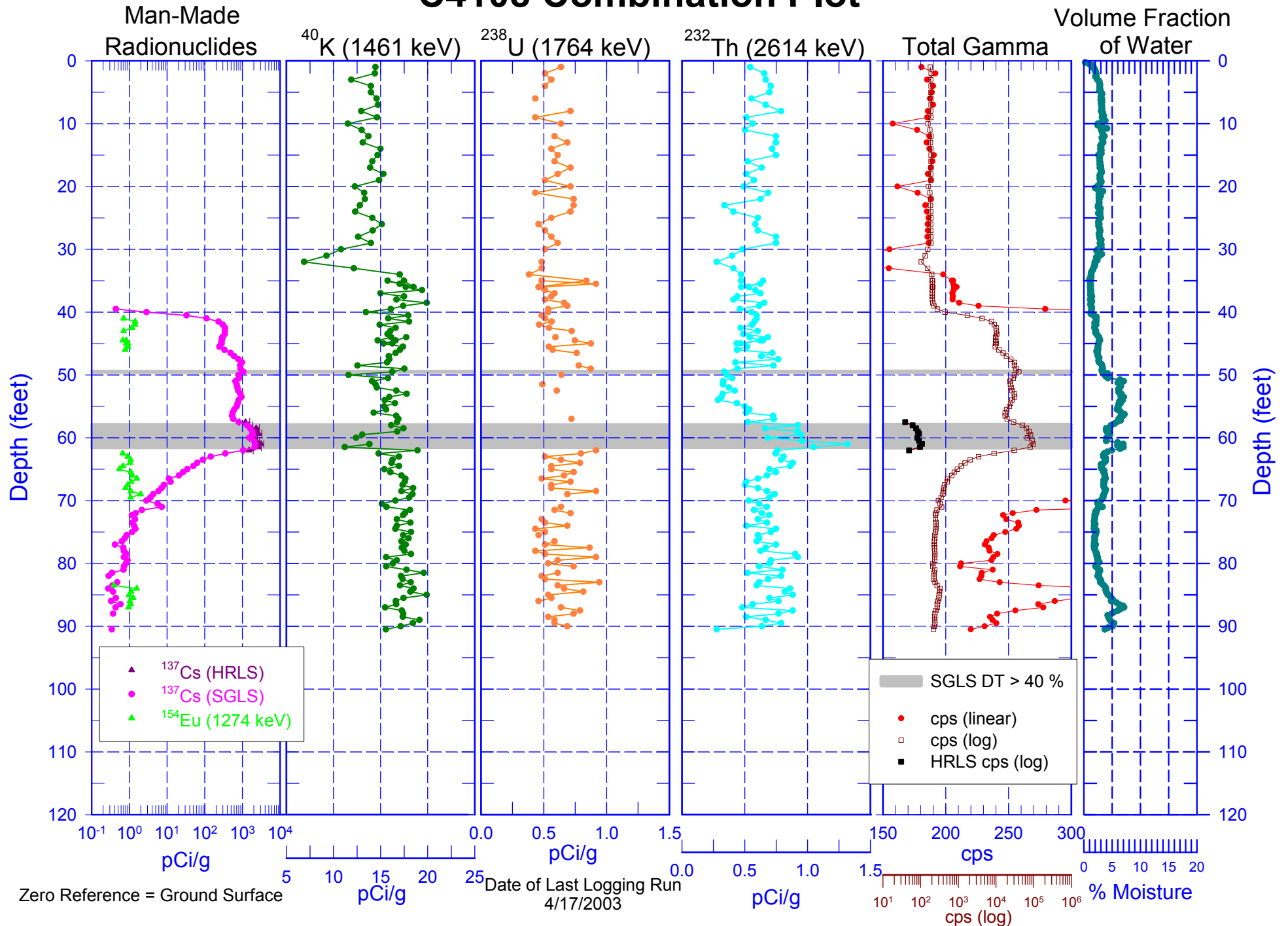
Natural Gamma Logs



Zero Reference = Ground Surface

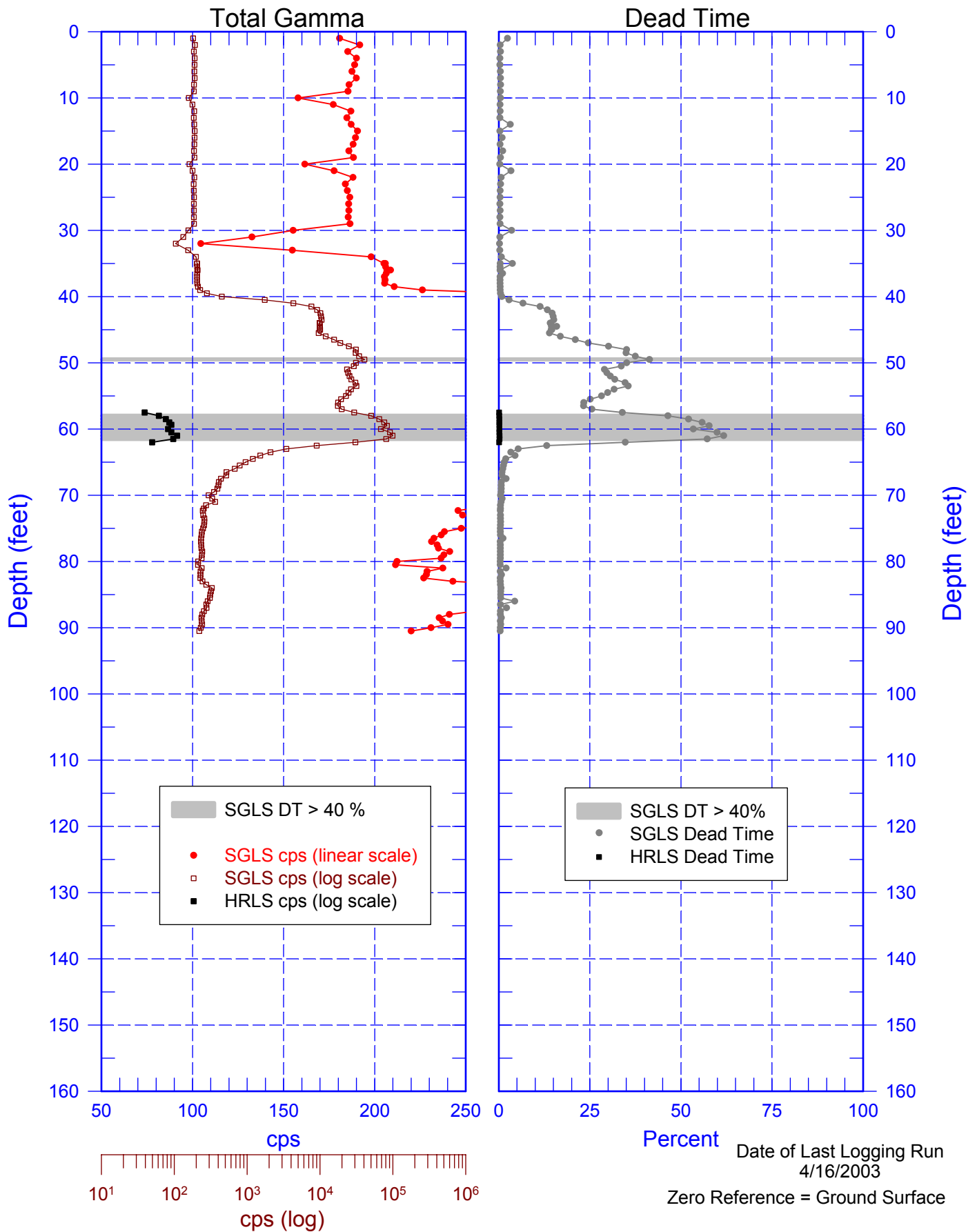
Date of Last Logging Run
4/16/2003

C4108 Combination Plot



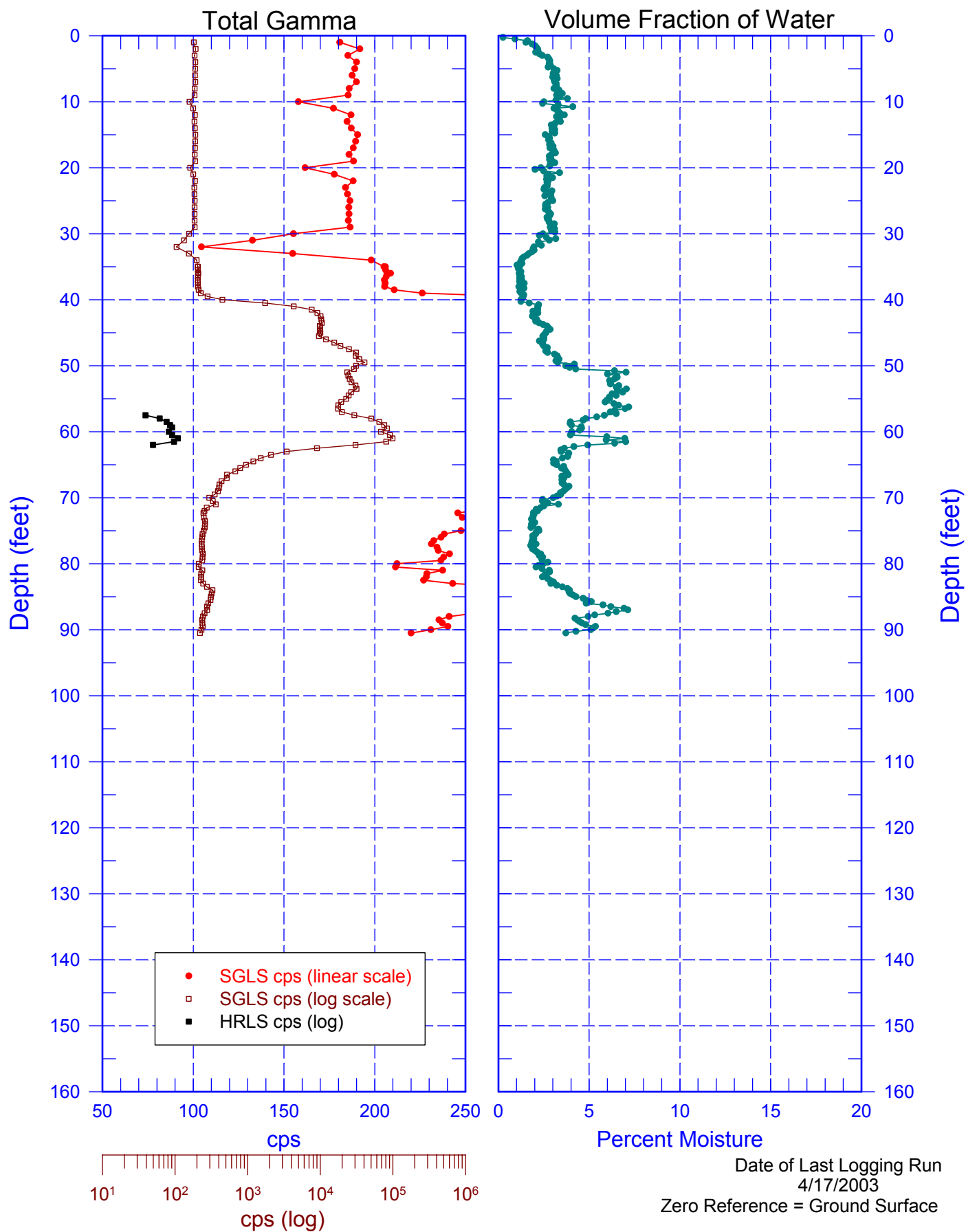
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Total Gamma & Dead Time



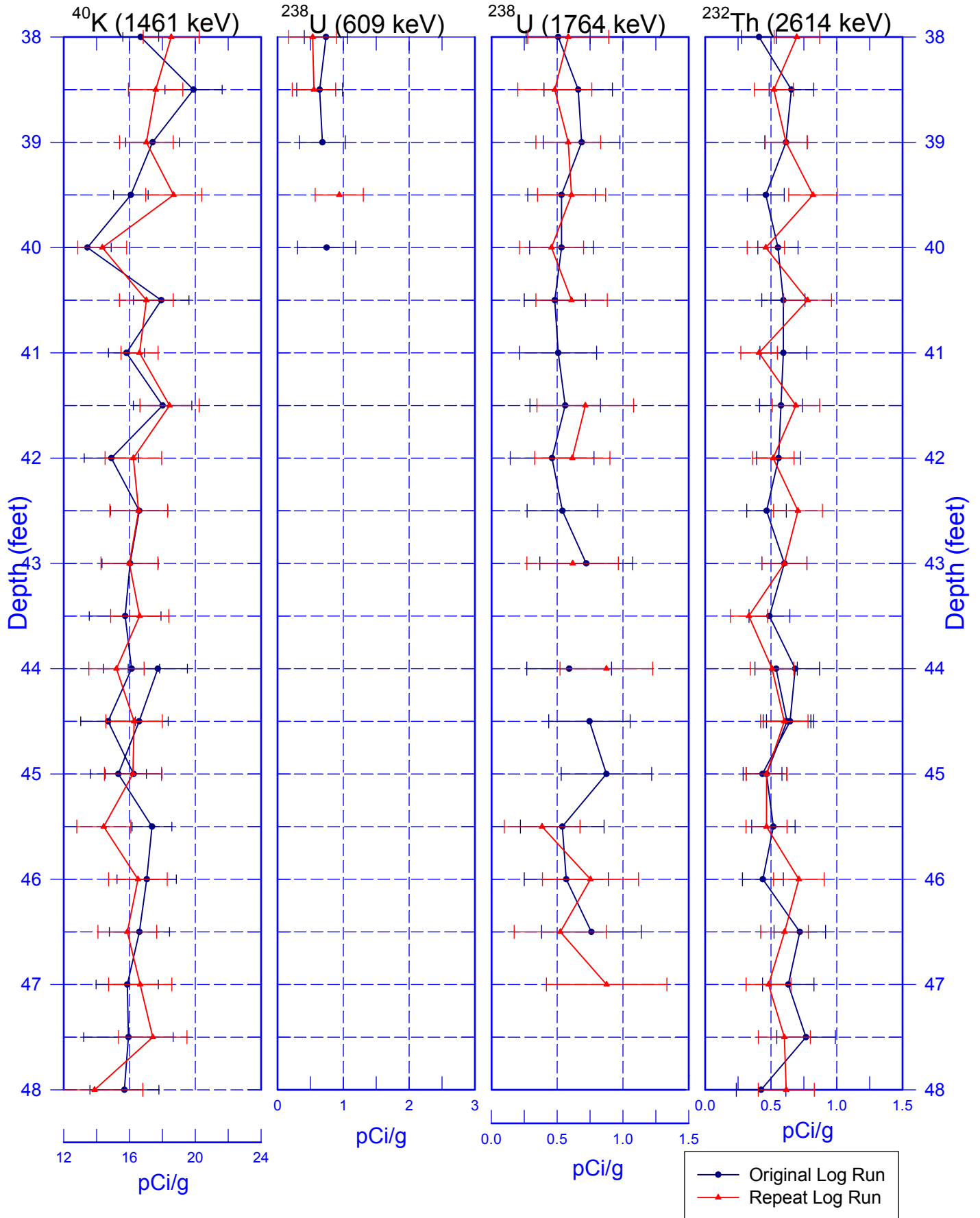
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Total Gamma & Neutron



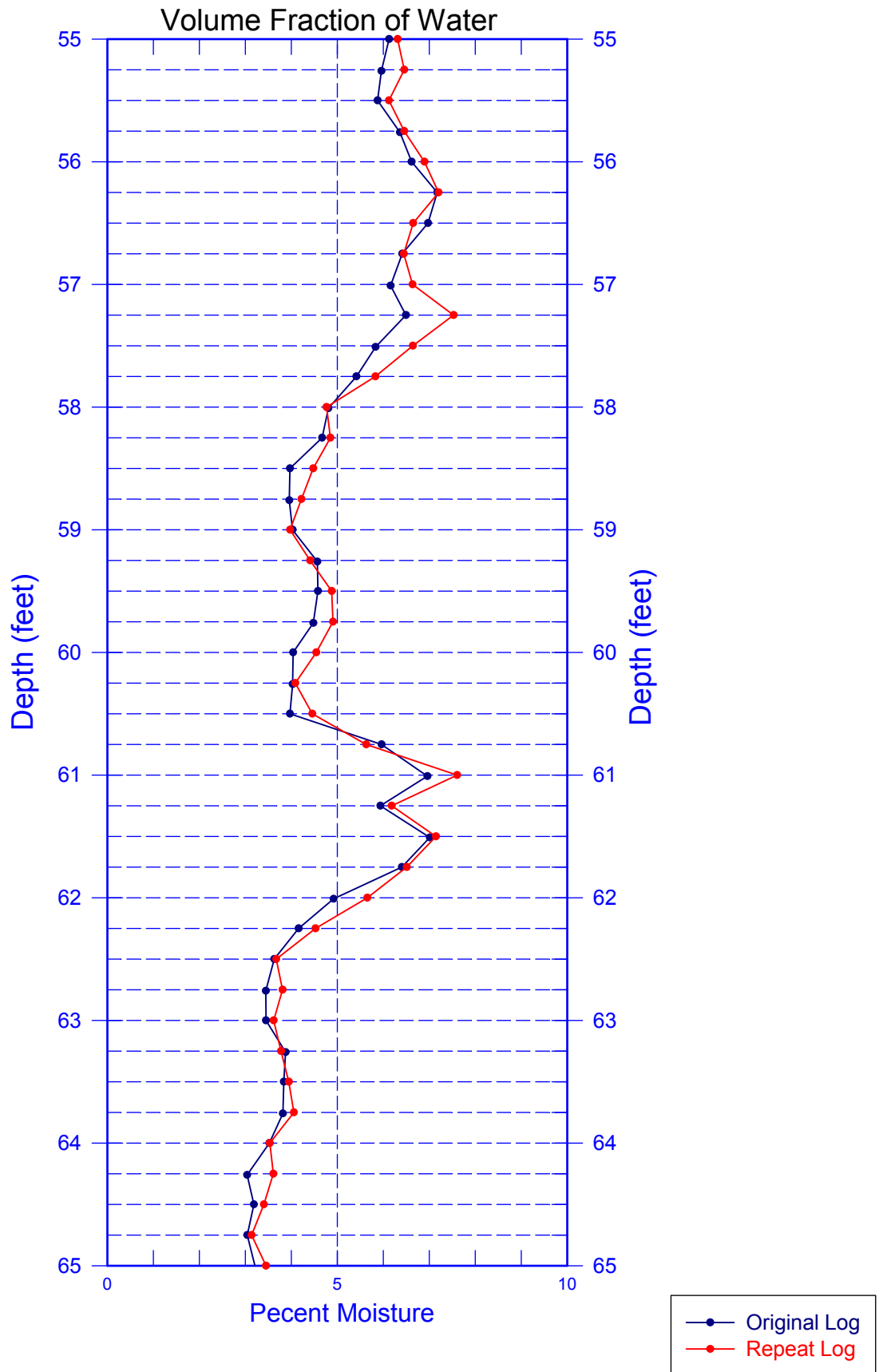
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Rerun of Natural Gamma Logs (48.0 to 38.0 ft)



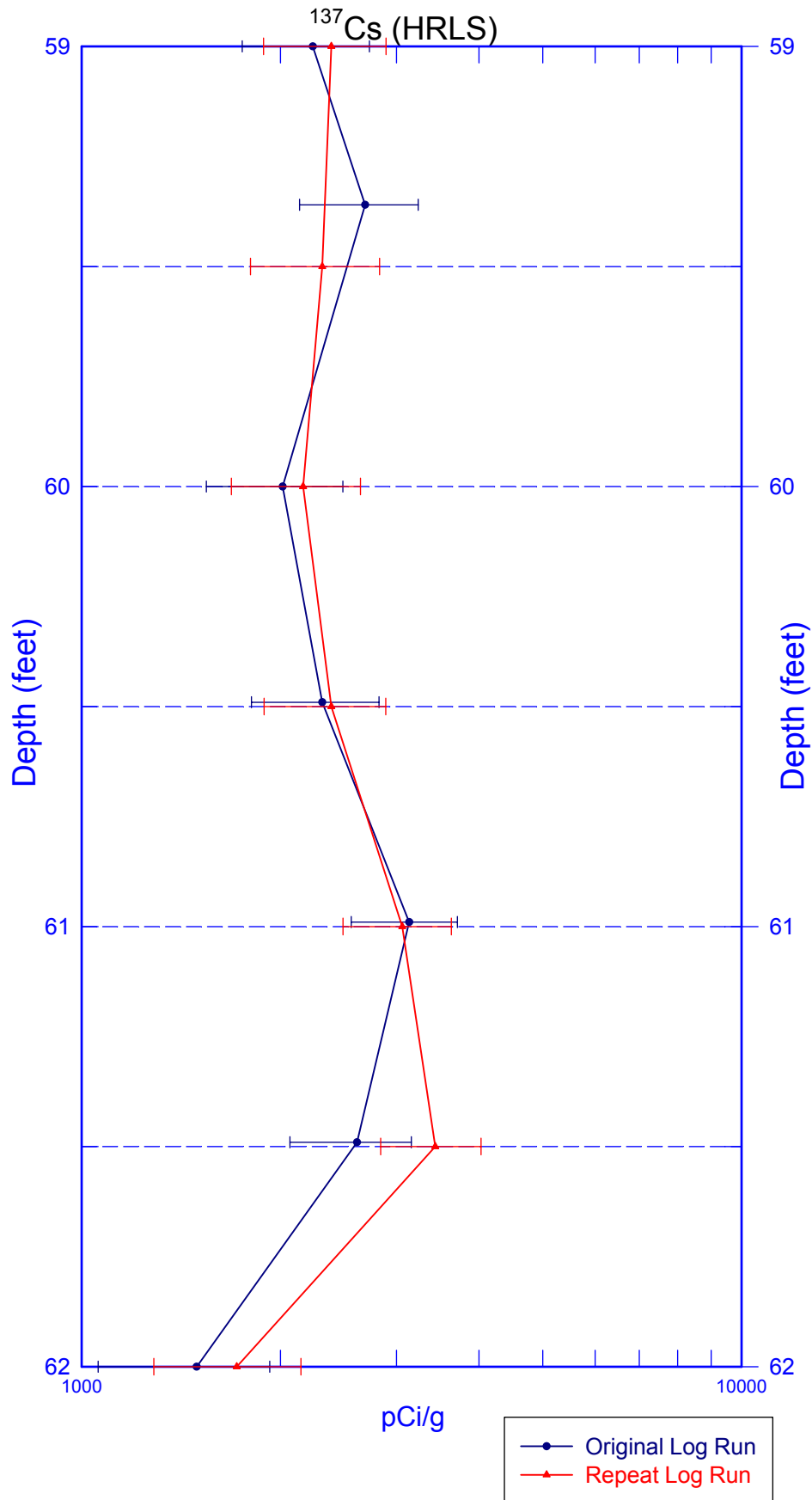
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Rerun of Neutron-Moisture Log (65.0 to 55.0 ft)



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Rerun of Man-Made Radionuclides



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Rerun of Man-Made Radionuclides

